

Part I

3. EXECUTION

3.1 Fabrication

3.1.1 General

Structural steel shall be shop fabricated in accordance with the applicable *AISC Specification*, *AISC Code of Standard Practice*, and *AWS D1.1*, as modified by the provisions of the contract documents.

High-strength structural steel shall be identified according to grade.

Members shall be marked and match-marked as needed for field assembly. Members shall be fabricated for delivery in a sequence that will expedite erection and minimize field handling of structural steel.

Cuts, holes, and openings in structural steel members, shown on the design drawings, shall also be shown on the shop drawings for structural steel and shall be done in the shop.

The Contractor shall cooperate fully with requests from inspection and testing personnel for access to the connections and joints to be inspected or tested. This includes beam and column turning in the shop, weld backing removal when nondestructive examination indicates rejectable conditions, and access to platforms or scaffolding as required to perform the work safely. Weld backing removal shall also be performed where required by the Contract Documents. When weld backing must be removed for test verification, the inspection must be performed in a timely manner so as not to hinder production nor require duplication of effort.

The Contractor shall conduct all necessary corrections of deficiencies in material and workmanship. Repair procedures shall be submitted to the Engineer for review and acceptance. The Contractor shall comply with requests to correct deficiencies, when such corrections are required by the Engineer or other designated responsible party. The Quality Assurance Inspector and NDT Technician shall be apprised of any repairs made by the Contractor.

3.1.2 Bolted Construction

Standard holes shall be used, unless otherwise indicated on the Drawings. Holes shall be drilled or punched at right angles to the surface of the metal, not more than 1/16 inch larger than the fastener diameter, except where oversize holes are specified. Making or enlarging holes by burning is prohibited, unless hole slotting is required between two punched or drilled holes. Center piercing with a torch and reaming to the required diameter is permitted. Material having a thickness in excess of the connector diameter plus 1/8 inch shall be drilled rather than punched. Burrs that would prohibit solid seating of the connected parts shall be removed.

Connections shall be assembled in accordance with the *RCSC Specification*, using provisions for pretensioned joints, unless snug-tight bolts are indicated on the Drawings. Faying surfaces of

pretensioned joints shall be prepared as for Class A or better slip-critical joints unless otherwise indicated on the Drawings.

3.1.3 Welded Construction

Each welder working on the project shall be assigned an identification symbol or mark. Each welder shall mark or stamp this identification symbol at each weldment completed. Stamps, if used, shall be the low-stress type.

Welding personnel shall be qualified in accordance with *AWS D1.1*, Section 4, Parts A and C. WPQR testing performed more than six months prior to the start of the welding by the welder is acceptable, provided written documentation is submitted showing that the welder has continued to use the applicable welding process on an ongoing basis since the test was conducted, with no lapse in service exceeding six months. Welders whose work routinely exhibits poor workmanship shall be requalified before performing further welding.

WPSs shall be available to welders and inspectors prior to and during the welding process. Prior to welding, joint fit-up shall be verified by the welder for conformance with the WPS and *AWS D1.1*.

For all complete joint penetration (CJP) and partial joint penetration (PJP) groove welds subjected to ultrasonic testing (UT), a visible mark, “for UT,” shall be accurately placed on the steel a distance of 4 inches away from the root of the edge preparation.

Welding shall be performed in accordance with the appropriate WPS for the joint.

Groove welds shall be complete joint penetration groove welds, unless specifically designated otherwise on the Drawings. Groove preparation details are at the Contractor's selection, subject to qualification, if required, in accordance with *AWS D1.1*.

Weld tabs shall be in accordance with *AWS D1.1*, Section 5.31, as modified by Section 4.2 of this specification. End dams shall not be used.

Backing bars shall be in accordance with *AWS D1.1*, Section 5.10, as modified by Section 4.1 of this specification.

Faces of fillet and groove welds exposed to view shall have as-welded surfaces that are reasonably smooth and uniform. No finishing or grinding shall be required, except where clearances or fit of other items may so necessitate, or as preparation for coating.

3.1.4 Headed Shear Studs

Shear studs shall be welded in accordance with *AWS D1.1*, Section 7, and the manufacturer's recommendations. Shear studs shall not be attached in the area designated in Section 5.5 of this specification.

3.2 Erection

3.2.1 General

Structural steel shall be erected in accordance with the *AISC Specification* and the *AISC Code of Standard Practice*, as modified by the project documents.

Where erection requires performing fabrication work on site, the work shall conform to the applicable standards of Section 3.1, Fabrication.

The Contractor shall cooperate fully with requests from inspection and testing personnel for access to the connections and joints to be inspected or tested. This includes weld backing removal when non-destructive testing indicates rejectable conditions, and access to platforms or scaffolding as required to perform the work safely. When such services are required, the inspection must be performed in a timely manner so as not to hinder production nor require duplication of effort.

The Contractor shall perform all necessary corrections of deficiencies in material and workmanship. The Contractor shall comply with requests to correct deficiencies, when such corrections are required by the Engineer or other designated responsible party. The Quality Assurance Inspector and NDT Technician should be apprised of any repairs to be made by the Contractor, prior to performance.

3.2.1.1 Storage and Handling

Structural steel shall be stored and handled in a manner that prevents damage or distortion. Do not store materials on the structure in a manner that might cause distortion or damage to members of the supporting structure. Store materials to permit easy access for inspection and identification. Keep steel members off the ground by using blocking, cribbing, platforms, or other supports.

3.2.1.2 Temporary Shoring and Bracing

Contractor's erection scheme and temporary bracing and shoring shall provide lateral support and stability for all columns until permanent lateral-support systems (for example: wind bracing bents and horizontal deck/slab diaphragms) are in place and complete. Provide temporary shoring and bracing members in vertical and horizontal planes as required, with connections of sufficient strength to bear the imposed loads. Remove temporary members and connections when permanent support systems are in place and final connections are made.

3.2.1.3 Erection Procedures

The Contractor shall be responsible for the control of all erection procedures and sequences including but not limited to temperature differentials and weld shrinkage.

3.2.1.4 Field Work for Other Trades

There shall be no field cutting of structural steel members in the Seismic-Force-Resisting System for the work of other trades without written prior approval of the Engineer.

3.2.2 Bolted Construction

Fasteners shall be stored in a protected place. Except for ASTM F1852 “twist-off” type assemblies, clean and relubricate bolts, nuts and washers that become dry or rusty before use. F1852 fastener components may be relubricated following the manufacturer’s written instructions, and must be retested after relubrication and prior to use to verify suitability for installation.

Do not use flame cutting to align bolt holes except as permitted by RCSC specifications.

Ream holes that must be enlarged to admit bolts. Do not enlarge holes by more than 1/32 in. Additional reaming beyond 1/32 in. shall not be performed without approval of Engineer. When reaming beyond 1/32 in. is approved, drill or ream to the next larger hole size and use the next larger size bolt.

Bolt holes may be made by punching or drilling. Bolt holes may also be made by thermal cutting to a smaller diameter, followed by reaming to the required diameter.

3.2.3 Welded Construction

See Section 3.1.3.

3.2.4 Headed Shear Studs

See Section 3.1.4.

3.2.5 Corrective Work

There shall be no field cutting or alteration of structural steel members or connections in the Seismic-Force-Resisting System without prior review by the Engineer. Structural elements having fabrication errors or which do not satisfy tolerance limits shall be repaired. Submit drawings showing reasons for, and details of, proposed corrective work for approval by the Engineer prior to performing corrective work. Corrective work shall be performed in accordance with the requirements of the Contract Documents. Pre-approved repair and correction procedures may be used when authorized by the Engineer for specific conditions.

3.2.6 Thermal Cutting

Thermal cutting torches may be used in the field for correcting fabrication errors in structural framing only with the approval of the Engineer. When thermal cutting is permitted, cutting shall be done only with a mechanically guided torch or a torch controlled using a guide bar, except as permitted below:

1. Thermal-cut edges that are not welded and will be free of substantial stresses, as determined by the Engineer, may be cut manually with an unguided torch provided the specified AISC edge distances to holes are maintained.
2. Other thermal-cut edges and edges to be welded may be cut manually with an unguided torch to a line within 1/8 in. of the finished dimension, with final removal of material completed by chipping or grinding to produce a surface quality equal to that of the base metal edges.

Cuts shall be smooth and regular in contour, and free of notches. The radius of reentrant corners shall be no less than one-half inch. Cuts performed to modify beam copes may be made with a smaller radius, but shall not be cut square.

Commentary: Thermal cutting of main members of the seismic-force-resisting system in the field should be performed with caution. If members are under load, when thermally cut, the resulting loss of strength could result in damage or failure of the member. Particular caution should be exercised with regard to thermal cutting in areas anticipated to experience yielding or buckling during earthquake response as the formation of martensite or the presence of excessive surface roughness or nicks resulting from such cutting can serve as initiators for fractures under high-strain cyclic loading. If proper precautions are taken, including shoring of heavily loaded members, use of preheat prior to cutting, and grinding to remove surface defects, field thermal cutting can be safely performed.

3.3 Supplemental Welding Requirements

3.3.1 Welding Personnel Qualification

3.3.1.1 Supplemental Welding Personnel Testing

Welders and welding operators performing work on welds classified as Seismic Weld Demand Categories A or B shall pass Supplemental Welder Qualification Testing, as prescribed in Appendix B, on special test joint mock-ups. Testing shall be performed using the process to be used in the work, with the WPS set at the highest deposition rate to be used in the work. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification. Tack welders need not perform such Supplemental Testing.

3.3.1.2 Qualification Period

Welding personnel required to be tested using the Supplemental Welding Personnel Testing prescribed in Section 3.3.1.1 shall be qualified by test within 12 months prior to beginning welding on the project.

Should the 12-month period elapse during welding on the project, the Supplemental Welder Qualification remains valid. It is not required to repeat the testing during the course of the project, unless the quality of the workmanship for that welder routinely fails to meet the applicable project weld quality standards.

3.3.2 Intermix of Filler Metals

For welded joints requiring CVN toughness in Seismic Weld Demand Categories A and B, when FCAW-S filler metals will be used in combination with filler metals for other processes, including FCAW-G, supplemental toughness testing shall be conducted as prescribed in Appendix C.

3.3.3 Electrode Storage and Exposure Limits

FCAW electrodes shall be received and stored in the original, undamaged manufacturer packaging, until ready for use. Electrodes in packages that have had the internal plastic wrapping damaged shall not be used for welds in Seismic Weld Demand Category A or B. Modification or lubrication of an electrode after manufacture is not permitted, except that drying is permitted as recommended by the manufacturer.

The exposure time limit for all FCAW electrodes shall be based upon the results of tests as prescribed in Appendix D. These tests may be conducted by the electrode manufacturer or supplier, by the Contractor, or by an independent testing agency or laboratory with suitable equipment.

In lieu of testing, when welding is to be suspended for more than 8 hours, electrodes shall be removed from the machines and stored in an electrode wire oven maintained at a temperature between 250° and 550° F, or as recommended by the manufacturer. Electrodes not consumed within 24 hours of accumulated exposure outside closed or heated storage shall not be used for welds in Seismic Weld Demand Category A or B. Electrode spools shall be identified to facilitate monitoring of total atmospheric exposure time. FCAW electrodes that have been exposed for periods exceeding an accumulated 24 hours may be dried if manufacturer's testing and recommendations show that drying is effective at removing moisture and restoring electrodes to their designated diffusible hydrogen level.

3.3.4 Wind Velocity Limits

In lieu of AWS *D1.1-98*, Section 5.12.1, GMAW, FCAW-G, GTAW and EGW shall not be performed when the wind velocity in the immediate vicinity of the weld exceeds three miles per hour. Welding performed within an enclosed area, and not subject to drafts may be deemed to satisfy this requirement.

SMAW, FCAW-S, and SAW may be performed without limitation to wind velocity, provided the wind does not affect the appearance of the molten weld puddle.

3.3.5 Minimum Preheat and Interpass Temperature

Minimum preheat and interpass temperatures shall be provided for all welds, including tack welds, in accordance with AWS *D1.1*, Table 3.2. The Contractor may specify higher minimum temperatures, if desired, as a part of the Contractor's WPS for a particular application. In such cases, the WPS minimum preheat and interpass temperatures shall be provided. For welds in

Seismic Demand Categories A, B, or C, preheat and interpass temperatures shall be in the range tested in accordance with Appendix A.

Preheat and interpass temperatures lower than those required by AWS D1.1, Table 3.2, are permitted provided the WPS has been qualified by test, and the WPS and PQR have been accepted by the Engineer.

Minimum preheat and interpass temperatures shall be verified at a distance of 3 in. from the weld, at the point of arc initiation or for materials over 3 in. in thickness, at a distance equal to the thickness of the part.

3.3.6 Maximum Preheat and Interpass Temperature

The maximum preheat and maximum interpass temperature permitted is 550°F, measured at a distance of 1 in. from the point of arc initiation. This maximum temperature may not be increased by the WPS, regardless of qualification testing.

Commentary: Limitations on maximum preheat and interpass temperature are imposed because laboratory data indicates that high heat input results in degradation of weld toughness. Use of qualified-by-test procedures with high heat inputs are not permitted because standard procedure qualification tests do not include evaluation of CVN toughness.

3.3.7 Nonfusible Backing

The use of nonfusible backing materials, including ceramic and copper, is permitted only with satisfactory welder qualification testing performed using the type of backing proposed for use, using the test plate shown in AWS D1.1-98, Figure 4.21, except that groove dimensions shall be as provided in the WPS and PQR. Should the joint to be welded include welding a beam flange to a column flange through an access hole, the Supplementary Welder Qualification Test of Appendix B shall be performed using the type of backing proposed for use.

For nonfusible weld tabs and short segments of nonfusible backing bars used at the ends of welds between shear tabs and column faces, or at the ends of continuity plate welds, special welding personnel and welding procedure qualification testing is not required. The welder shall be trained in the proper welding techniques for using such nonfusible weld tabs and backing bars prior to performing such welding on the project.

3.3.8 Peening

The use of peening is permitted at the Contractor's option, but is not required. See AWS D1.1-98, Section 5.27. If the Contractor elects to use peening, a written procedure for performing peening shall be incorporated into the WPS for the joints to be peened.

3.3.9 Controlled Cooling

The use of controlled cooling is permitted at the Contractor's option, but is not required. If the Contractor elects to use controlled cooling, a written procedure for controlling cooling after welding shall be incorporated into the WPS for the joints to receive such treatment. The procedure shall include the method of heating, the maximum temperature permitted, cooling rate range to be provided, and the method and frequency of temperature measurements.

The use of insulating blankets after completion of welding, without the addition of heat, is permitted at the Contractor's option, but is not required. For the use of insulating blankets only, a written procedure and temperature measurements are not required.

3.3.10 Post Weld Heat Treatment

The use of Post Weld Heat Treatment (PWHT) is permitted at the Contractor's option, but is not required. The use of PWHT shall meet the Stress-Relief Heat Treatment limitations of AWS *D1.1-98*, Section 5.8. If the Contractor elects to use PWHT, a written procedure for performing PWHT shall be incorporated into the WPS for the joints to be treated.

Controlled cooling, or the application of heat immediately following completion of a joint to maintain a nominal temperature at or below 550°F, is not considered PWHT.